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Eastbourne.—The March meeting will take place (by the kind invitation of Mrs. Cardwell) at the Moat Croft, Upperton. The lecture will be given by George Langley Esq. Subject, "Music as a factor in education."

Hastings and St. Leonards.—On February 11th, a lecture was given by T. G. Rooper, Esq., H.M.I., at Caple-ne-Ferne (by kind permission of Mrs. Tubbs). Subject, "Lord Collingwood as an Educationalist." The Rev. F. R. Burrows took the chair in the place of the Rev. H. J. Graham, who was unable to attend at the last moment. The next meeting will be on Tuesday, March 22nd, at 33, Marina (by kind permission of Mrs A. C. Routh), when Mrs. Wilberforce will give an address on "Family life."

Scarborough.—Owing to bereavement the Bishop of Hull has postponed his meeting until after his term of residence in York is over.

Bolton.—A meeting was held at Hetlands (by kind permission of Mrs. Crook), on Monday, February 7th, when *Levana* was discussed. Mis. Knowles read a short paper giving her impressions of the book, and other members took part in the discussion. There was a good attendance.

Farnworth.—A meeting was held (by kind permission of Mrs. Nuttall) at Wellington House, on Monday, January 31st, when the Rev. H. E. Burgess, M.A., read a very able paper on "Disciplinary Methods." The members who were present greatly enjoyed the paper and found it most suggestive and helpful. The next meeting will be at the Vicarage, when Miss Roberts will read a paper on "Pestalozzi," as Miss Mason is prevented from coming.

Chichester.—It has been arranged that the first lecture will be given by Mrs. Franklin, hon. organizing sec., at 3 o'clock, on Tuesday, 22nd February, in the Council Chamber (by the kind permission of the Mayor). Particulars of the other lectures will be duly notified beforehand.

Edinburgh.—On Tuesday afternoon, January 18th, Mr. J. Arthur Thomson read an exceedingly interesting paper, on "The Play of Animals." Dr. Clouston, whose paper, "What the Brain has to do in Childhood besides being Educated," was expected for this date, has been obliged to give up lecturing this winter on account of ill health. The meeting was held (by kind permission of Mrs. Whyte), at 7, Charlotte Square. Dr. Alex. Whyte in the chair. The large audience enjoyed greatly Mr. Thomson's delightfully suggestive paper. The next meeting will be held on Tuesday, February 15th, at 29, Charlotte Square, when John Marshall, Esq., M.A., LL.D., will deliver an address, entitled "Naughty Boys."

THE
PARENTS' REVIEW
A MONTHLY MAGAZINE
OF HOME-TRAINING AND CULTURE.

"Education is an atmosphere, a discipline, a life."

WHY AND HOW SCIENCE SHOULD BE TAUGHT TO YOUNG CHILDREN.*

By T. G. Rooper, M.A., H.M.I.

Judging from letters in the newspapers and the reports of lectures by brilliant "humanists" and highly-cultured professors of ancient literature, there are still not a few able men who denounce the attempts that are being commonly made in all countries to introduce science teaching as a part of the course of general education. The fine old crusted classical scholar, who shows no understanding of the methods of modern science and no sympathy with its aims, writes and talks very superciliously of physiography and hygiene. Condemning such studies in good set terms, he writes on educational subjects somewhat pharisaically, thanking the Almighty that he is not as one of those educationalists who, to promote their private fads, introduce such stuff as that into the school lessons.

It is human to err, and students of education are no more infallible than other students, but, since that prophecy—Lord Bacon's favourite—is amply fulfilled which says, "Many shall run to and fro, and knowledge shall be increased," educationalists can hardly be departing far from the judgment of common sense when they insist upon it that old plans of school instruction which are adhered to in such a conservative way that they remain wholly unaffected by new and far-reaching extensions of scientific discovery, must needs be quite inadequate to the times in which we live. Adhering ignorantly to ancient well-worn paths of learning in spite of much new light, they seem to me to resemble the well-remembered mob who, on the advent of a higher religion, continued to shout boisterously, "Great is Diana of the Ephesians," through not understanding the new situation. Most beginnings are difficult, and the introduction of science into schools has proved no easy undertaking. But educationalists are willing to admit their mistakes when intelligently pointed out and will endeavour to reform, and they will console themselves meanwhile with a remark of Plato's, where he says :—"Let us not cast a slight upon education, which is the first and fairest thing that the best of men can ever have, and which although liable to be misdirected is capable of reformation."

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* A paper read before the Derby Branch of the P.N.E.U.

I would endeavour to assist you to-day to obtain clear ideas of the aims of science teaching, so that you may form a correct judgment of the place which it should fill in the scheme of general education. For I think you may depend upon it, that the time is not far off when an entire ignorance of elementary science, which is now so often acknowledged with unctuous satisfaction, will be considered fatuous and vulgar. Science is forcing its way into education, and the old learning is being compelled, whether it will or no, to assimilate the new. But let us beware in our schools of excessive division of labour and study. We shall not get the best results from our system if teachers of different subjects work each "for his own hand," disregarding the claims of other teachers in other subjects. Unity of purpose, amid a reasonable variety of studies, is essential to a good system of education. There is need that one subject should support another and be seen in relation to other subjects. There is need in higher education that teachers of different subjects should provide each other with mutual support, sympathy and co-operation. There is no true wisdom in the man of literary culture whose educational ideal permits him to remain in blind ignorance of the great world of nature in which he has to live out his life. We may accept with our friend in the *Times*, Aristotle's description of good government, as being also the description of the object of education.

His words are worth quoting :—"Its greatest and highest end and aim is to make virtuous and good citizens, to secure the happiness arising from blamelessness of life, to lead to the perfection of man's social and moral nature, and to encourage those great and noble deeds which dignify and adorn a country." This is a noble saying of a great thinker, but we shall ill do honour to his maxims if we ignore in our system of education all the extension of scientific method and knowledge which has taken place since his time. The true aim of education is the production of the perfect citizen by the development of moral, mental and physical faculties.

But stimulating as they are, these generalities carry us but a very little way towards our aim so long as details are left out of sight as too obvious to need explanation. The filling in of the picture is quite as important as the rough sketch or the design. Moral development, I am convinced, depends less on the subject taught than on the moral worth of the teacher. In the end the principal result of the teacher's instruction, whatever his subject may be, is the transmission of his own character. He teaches more or less of his subject, but he inevitably teaches himself.

Science, it is perhaps often thought, does not exercise an ennobling influence; it has rather a debasing effect, robbing life of beauty, romance, reverence, and mystery.

But does ignorance of science preserve reverence? I doubt it. The other day Mrs. Boole, who is a teacher of exceptional power and experience, the widow of a famous writer on logic, stated that she had known girls who were allowed to grow up with a purely literary training, lose their faith in religion at the very first unavoidable introduction to the commonplaces of modern science. Believe me, there is more of irreligion due to the omission of science from early education than to any other cause.

The sceptic without any ideals — moral, social, or religious--is, perhaps, not more to be pitied for the barrenness of his life than an ignorant mystic who is entirely without the means of distinguishing fact from fancy.

On the occasion of General Westmacott's recent attack on Jarobi, the village of Hadda Mullah, that enthusiast who has stirred up the tribes on the Indian N.W. frontier, a brother Mullah named Suffi, promised to stop the mouths of the infidel guns, and this superstitious belief in their immunity from bullets is said to have inspired the Mohmands with much courage. The *Times* remarks that while this promise of Suffi Mullah showed considerable knowledge of human nature, it was open to the grave objection that it had to be put to immediate proof, and as the proof demonstrated in the most convincing way that somehow or other the holy man's prayer did not stop Lee-Mitford bullets, the *Times* commends the wiser procedure of Hadda Mullah who deferred proof of his words by promising the material joys of the Mohammedan paradise in another world to those who fell bravely in the struggle.

No doubt as the truths of science become the common property of all, such superstitious belief as this will fall away. Does then mystery cease? Is wonder extinguished? On the contrary, wonder will become not less but more, only it will be manly and intelligent. Which is the better, the blind childish wonder, the wonder of the ignorant savage and all the gullibility which belongs to it, or the wonder of the educated mind, which realises that it is permitted to read a little, if but a little, of the Creator's mind?

In my view then the danger to educational systems is not the introduction of elementary science but the absence of it, and science is as essential as literature to form a sound mind. Therefore, I am not content to base the claims of science in general education on purely industrial or utilitarian grounds. Did science, however useful in trade or industry, displace from our educational system studies that were ennobling, the loss would far outweigh the gain, but as a part of our educational system it has an educational value in disciplining the understanding which no other study supplies with equal effect.

The study of Natural Science upon modern methods is a remedy against a belief in a series of propositions merely because they are consistent. What is true is consistent, but what is consistent is not therefore in all cases true. Hasty deductions from observation of Nature may lead to vague premises, from which conclusions are consistently drawn, but are nevertheless false.

A general principle in modern science, to be sound,

should assert something about facts of experience which can be tested. It must lie close to experience and observation and be capable of verification at any moment. Hence the difference is apparent between a mediæval maxim, like "Nature abhors a vacuum," and Newton's "Law of Gravitation."

It must not be overlooked that since the first dispute arose between the humanists and the realists, between literature and science, the method and scope of science have much changed. Science, in the days of Linnæus, was largely classificatory. The aim of the scientific man was to collect information—he wished to *know*. At the present time the aim of science is command over Nature. By delicate measurements, by patient observation of processes, by most laborious microscopical observation, by long courses of varied experiments, the forces of Nature may be brought under control; and while electricity is made a servant of man, minute organisms which cause disease are employed in producing a remedy or a prophylactic for them. The aim of science is not merely to classify and organise knowledge, but to *do*.

Some will object that knowledge is not power, and that a good housemaid will be more expert at lighting a fire than a professor of physics who is learned in the knowledge of heat. I am, however, constantly coming across cases where practical experts fail in the use of modern machines for lightening the work in house and farm in consequence of want of general scientific knowledge. I will tell you a true story. A farmer's wife not long ago bought a Swedish separator for separating the cream from the milk. Anyone who has ever examined the cylinder of this machine after use must have noticed what a foul residuum is separated from the milk and left clinging to the inner walls—chiefly traces of blood and dirt. Of course the machine needs scalding immediately after use. Now, my farmer, after using his machine for six weeks, complained to a friend that it was a complete failure, and would not work. His friend examined the machine, and found that the farmer's wife had never washed it since she had bought it, though using it constantly.

I am perfectly certain that no one with a proper school training in simple science would be so helpless as this farmer's wife with her new machine, and those who think that education in Denmark has little to do with the commercial success of the Danes in making and exporting butter little realise the kind of effect that good general education produces not directly but indirectly. Now, the effect of educational reforms readily escapes the notice of Commissioners who are sent to study them, because they are indirect.

Science is ubiquitous in modern life. There is science in the home, from kitchen to nursery; there is science in the farm, whether in dairy or byre, in orchard or field; there is science in the Municipal Chamber, and it must be domesticated in the Mayor's parlour, or else woe be the town over which he presides. The fruit of ignorance is poverty, disease and death.

The discoveries of science cannot be universally applied unless the early training of children produces a tone of mind which shall be in harmony with scientific reasonings, and receptive of scientific facts.

The advice of experts is as seed falling on barren soil, unless the minds of men are in early years exercised in, however elementary a way, the methods which are pursued by those who are carrying on scientific research.

Now there are, of course, an indefinite number of suitable courses of scientific instruction for young children, but all of them should start with a study of the immediate surroundings of the child.

The following is a course suggested by Dr. Dufton, who has paid much attention to the matter, and is a high authority.

In the part of the country in which I live chalk is one of the most prominent features in every landscape, and indeed there are few parts of England where chalk-pits or limestone quarries cannot be easily visited.

Chalk, then, is a suitable starting-point in science for children in this district. It is wise to commence with the grosser forms of matter and pass through them to subtler forms of it, such as gas. Children of eight or nine years of age might easily in their object and geography lessons learn from an attractively coloured geological map the distribution of the chalk hills in England. Some pictures, or, better still, some lantern slides, could familiarise them with the chalk hills of Dover, with Shakspeare Cliff and Flamborough Head. Flints can be obtained, broken open, and the fossil sponges or other fossils examined. Lantern slides or diagrams will show the minute structure of chalk, limestone, and marble, and the origin of chalk is simply deduced from the crumbling of the shells of the marine organisms, many of which may be found in the chalk. A visit to the east or west end of the Isle of Wight will show chalk cliffs where the layers stand on end, and if an expedition is impossible lantern slides can easily be obtained, for teachers in the Island are many of them photographers. In this way the movement of the crust of the earth, the contortion, compression, and upheaval of rocks originally laid down under the sea, can be suitably demonstrated. The Solent itself and the many inlets on the coast of Hampshire seem to illustrate the sinking of the land. Modern deposits somewhat similar to chalk and limestone would naturally be dealt with, and specimens of coral reefs, coral zoophytes, and bits of real coral could be secured with ease in a port like Southampton. Slides would illustrate coral islands, reefs, and rings.

Both above and below the chalk there lie sandstones and clays. These might also be pointed out, and the rapid wearing away of these strata along the Hampshire coast and in the Isle of Wight might be shown by lantern slides. The formation of sand by the wearing of rocks through running water, frost, rain, wind, waves, and the like can be explained, and sand can be compared with clay. In connection with clay, the white china clay of the pits between Swanage and Corfe Castle can be shown in specimen, and the description of the Staffordshire potteries to which it is sent can be given. The coarser clay makes garden pots, and the Fareham or other potteries could be probably visited. Lastly, there are the brickworks to describe and see. Clay, shale, and slate naturally explain each other, and the origin of the school slate can be readily made clear. Beneath the chalk and other measures we find coal-bearing strata, and the origin of coal, with specimens of ferns and leaves visible in it, can be shown, and lantern slides will illustrate the restored vegetation and animal life of the carboniferous epoch. The manufacture of charcoal, coke, and coal gas will naturally be explained here.

We have thus dealt with chalk, sandstone, clay, and coal in such a way as to form an introduction to geology, sound as far as it goes. We have incidentally explained some important manufactures, and have given a power of observation which will make every gravel heap interesting and add zest to every country walk, even if the scholar after leaving the elementary schools studies geology no further.

As the children pass to higher standards they can proceed to the study of matter in a more subtle form. It is possible to connect this study with the chalk which was our starting-point. The process of lime-burning may be described and experimented upon. Limekilns, where at hand, may be visited. The difference between chalk and quicklime may be experimented with. In making quicklime from chalk the loss of weight may be demonstrated and measured, the children taking part in the experiment. Further, the gas which escapes in burning chalk may be collected and tested. Paragraphs from newspapers may be read describing the death of tramps who have in winter, for warmth's sake, slept against a limekiln, and been choked by carbonic acid gas. Then lime can be slacked, and the great heat evolved noted and the production of solid slaked lime. In this connection the use of mortar and its behaviour can be shown. Chalk, slacked lime, and old mortar may then be treated with vinegar and other common acids. The evolution of gas may be noticed, and inference drawn as to the cause of the setting of mortar. Then should follow the preparation of carbonic acid gas from various sources, and an examination of its more important properties.

Of course all this simple experimental work is an introduction to the elements of chemistry, and the nature of a chemical change has been well illustrated in lime-burning, slacking mortar, and the action of acids on chalk.

Slacked lime may then be compared with other alkaline substances in common use, such as ammonia, washing soda, and caustic soda. Then should follow the observation of the general properties of acids by simple experiments with vinegar, citric, tartaric, and oxalic acids, and oil of vitriol, spirits of salts, and aqua fortis. A few salts of the acids may be prepared before the class in a crystalline condition, so as to give familiarity with this important class of compounds, and make clear the relationship between the acids and the alkalis.

The next step might be the properties of the common metals, which may be compared together—iron, steel, copper, lead, &c., especially in the form of thin bands or wire. The process of iron manufacture can be explained. Iron ore is mostly oxide of iron, and by heating it with charcoal the iron is separated from the oxygen. Then follows the difference between the properties of wrought iron, cast iron, and steel, and the influence of this difference on the choice of metal for particular purposes.

Rust of iron may be the subject of experiment. It may be shown that iron by rusting gains in weight, either by use of a balance or by filling a bottle with coarse filings made damp and held in position by wire gauze and then inverted over water. As the filings rust they take oxygen from the air in the bottle, and water rises to take its place. Iron filings burn with bright sparks when dropped into hot fire, and they are used in making fireworks for producing vivid scintillations.

Next should follow the effect of dilute acids on iron. As in the case of chalk, a colourless gas is evolved, but it is not the same gas. It has very different properties. The new gas, hydrogen, is lighter than air, combustible, and producing water when burnt. The solution of iron in the acid contains a salt. If sulphuric acid be employed the iron sulphate or green vitriol may be crystallized out and shown.

The relative weights of hydrogen and air may now be shown. This leads to noticing that air has weight. Experiments may be devised for weighing it like tea or sugar. Air having weight presses down on all things, and the magnitude of this pressure may be shown by striking illustrations, followed by an account of some of the more important applications, such as syphons and water-pumps, and the barometer may be constructed and its use explained.

The analysis of water may now be returned to. Hydrogen may be passed over some iron oxide (ignited iron rust) heated in a hard glass tube: the red oxide turns to a black iron powder, which will attract a magnet, and water condenses in the cooler parts of the tube. If some of the slightly warm iron dust be poured out of the tube it glows, forming iron oxide again by combination with part of the air. Water is thus a compound of hydrogen with the portion of air absorbed by the moist iron. This deduction may be confirmed by the electrolytic decomposition of water, the two gases, oxygen and hydrogen, being collected separately and their properties examined and compared.

Next follows Priestley's method of preparing oxygen from red oxide of mercury, upon which is founded Lavoisier's classical proof of the composite nature of air. Mercury heated in a confined quantity of air gains in weight, changing into a red powder. The air loses weight to the same extent as the mercury gains, and decreases in volume by one fifth, the residue being nitrogen. On heating the red powder produced the mercury is all recovered, unchanged in weight, and a quantity of oxygen liberated equal in volume to the loss experienced before by the air. Five parts of air by volume have been separated into four parts of nitrogen and one of oxygen. The mercury has entered into combination and been released again without loss. This absence of any loss of weight in chemical change is found to be a general fact. As a further illustration of it, a candle may be burned and the products collected—the whole apparatus gains in weight, showing that matter has not been destroyed. Hence Lavoisier's inference that "Matter can neither be created nor destroyed," which is one of the fundamental laws of modern science.

The knowledge of oxygen now acquired makes an understanding of respiration possible. The main facts of respiration and the necessity for adequate ventilation of houses of man and beast can be brought home to the children.

A thorough study of the physical properties of water may follow. First the volume changes accompanying the changes of state from ice to cold water, and hot water to steam, and the curious but exceedingly important abnormality in the expansion of water when heated, should be illustrated by experiment. The expansion of solids and gases may be shown, and the practical importance of expansion and the precaution necessary in consequence, when iron bridges and railways are constructed.

The construction and use of a thermometer follows naturally in this connection, and the meaning of the term temperature may be made clear. Practical measurements of heat should be made. The heat unit should be explained, and then a few specific heats and the latent heats of fusion of ice and of vapourization of water determined. The heating of a gas during compression and corresponding cooling by expansion having been explained, children can understand the elements of weather lore, or meteorology, and of climatology; the tempering of climate by the sea, the phenomena of land and sea breezes, and the formation of rain and fog; the cooling effect of a passing shower, &c.

A course like this has consistency in itself, and is continually in touch with every-day life and things familiar to the children. It gives by degrees a knowledge of the fundamental laws and facts of modern science. It secures a habit of careful, accurate and all-round examination of common things, and without such a course this habit is almost unformed by ordinary education.